

Soundscape, Quality of Life, and Health: Paper ICA2016-226**Application of the Swedish Soundscape-Quality Protocol in one European and three Latin-American cities**

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Abstract

The Swedish Soundscape-Quality Protocol (SSQP) is a tool developed to evaluate and classify acoustic environments according to their acoustic perception by people. This protocol has been proposed by Axelsson, Nilsson and Berglund and it is based on a pleasantness-eventfulness principal component model. This model is feed by qualitative measurements of the extension of eight attributes of Soundscapes and allows one to classify the acoustic environments in four Cartesian quadrants: exciting, chaotic, monotonous, and calm.

In the present work, the SSQP is applied in urban environments in four cities: Córdoba and Rosario (Argentina), Valdivia (Chile) and Lund (Sweden). The protocol was evaluated through 509 surveys conducted in 122 locations corresponding to 29 open public environments in these four cities. The evaluated environments included parks, squares, streets, avenues, pedestrian streets, cultural spaces, fountains and other recreational facilities. Results show that most urban parks and squares were classified as exciting, while a minority of them was assessed as calm. Most locations on streets and avenues were evaluated as chaotic, whereas most locations in pedestrian streets were categorized as exciting. Not a single urban environment was classified as monotonous.

Keywords: soundscape, soundscape quality, environmental acoustics, urban environments.

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1 Introduction

The Soundscape paradigm focuses on people perception and understanding of acoustic environments [1]. Thus, soundscapes are experienced by people in context and this experience depends both on the environment and the intrinsic factors of the individuals. These factors comprise their current activity, state of mind, preferences, previous experience in the environment, personal history, among others [2]–[4]. In this direction, different models have been proposed aiming to represent the main aspects of soundscape perception. This section outlines chronologically, firstly, perceptual models and, secondly, soundscape quality indicators. In both topics the research outcomes have been varied and dissimilar.

In respect to perceptual models, Kawai et al. obtained three major factors which are preference, activity and sense of daily life [5]. Kang synthesized perception into four factors: relaxation, communication, spatially and dynamics [6]. Guillén and López Barrio proposed three relevant dimensions which explained two thirds of the total variance: emotional evaluation and strength, activity and clarity [7]. Axelsson et al. achieved to synthesize the total variance of the soundscape attributes in a three-dimensional space of pleasantness, eventfulness and familiarity [8]. Cain et al. explained most of the variance by two principal components: calmness and vibrancy [9].

Regarding soundscape quality evaluation, different approaches have also been proposed. Yu and Kang modeled the acoustic comfort by mean of an artificial neural network aiming to get a measure of the soundscape quality [10]. Jeon et al. studied the quality of urban soundscapes containing water sounds by mean of Likert scales of comfort, pleasantness and annoyance [11]. Brambilla et al. have investigated the soundscape quality in Italian parks by mean of interviews that considered the rating of some environmental aspects: vegetation, clean, air, cleanliness, security, quietness, and overall perceived quality [12]. Tse et al. analyzed soundscape quality in parks by applying questionnaires to obtain psychological responses to different types of natural sounds. Then, multivariate techniques for establishing relationships between acoustic comfort evaluation and its influencing factors (acceptability of the environment, visual comfort, preference to stay in the park area due to soundscape and Leq, among others) were employed [13]. Maristany et al. applied a fuzzy logic model combining acoustic and psychoacoustic descriptors for representing soundscape quality [14].

In parallel to these two mentioned research areas, Axelsson, Nilsson, & Berglund had been maturing a soundscape-quality protocol [15]–[18], which was supported by a comprehensive perception model [8]. This protocol was named Swedish Soundscape-Quality Protocol (SSQP). Subsequently, the SSQP had been applied, discussed and validated [19]–[21]. The perceptual model that supports the SSQP considers originally 116 soundscape attributes, which were

synthesized by principal component analysis into 3 synthetic variables called pleasantness, eventfulness and familiarity, explaining the 50, 18 and 6% of the total variance, respectively [8]. As a result, the SSQP was structured on a pleasantness-eventfulness ortho-normalized two-dimension model. The ISO 12913 series on Soundscape are intended to include soundscape quality evaluations inspired by the SSQP [22].

This work presents the results of the application of the SSQP in 29 open public environments of four cities: Córdoba and Rosario (Argentina), Valdivia (Chile) and Lund (Sweden). The environments evaluated included urban parks, squares, universities campus, fountains (and other water facilities), pedestrian streets, main streets, commercial, residential, recreational and cultural areas.

2 Methodology

For the application of the SSQP, field surveys were conducted. Depending on the environment, two different sampling strategies were applied: *fixed-locations* (FL) and *soundwalks* (W). The first strategy implies a non-probabilistic accidental sampling to the available individuals who are spontaneously in the environment. The W strategy implies a non-probabilistic incidental sampling by introducing individuals in the environment [23]. The statistical analysis was conducted separately for each sampling strategy [24]. Most of the environments were studied according with F-L sampling strategy, while the W sampling strategy was applied in the rest of them. There were some environments that were evaluated with both strategies (in different moments). In this article, only the results corresponding to the sampling strategy with the higher N are presented for each environment, which summarizes a total of 444 cases.

The questions related to the SSQP correspond to a part of a comprehensive sampling of soundscapes that included an extended survey, acoustic measurements, audio recordings and audiovisual acquisitions, whose outcomes exceed this article. The question of the questionnaire used to feed the SSQP was:

“To what extent do you agree with the 8 statements below on how you experience the present surrounding sound environment: pleasant, chaotic, exciting, eventful, calm, annoying, uneventful, monotonous (please tick off one response alternative per statement: agree completely, agree largely, neither agree nor disagree, disagree largely, disagree completely).”

These 8 statements represent the input variables for feeding the pleasantness-eventfulness ortho-normalized bidimensional model used [20], [21]. The graphic representation of this model is a Cartesian coordinate system that facilitates the classification of soundscapes into four quadrants. The first quadrant corresponds to those environments that were classified as exciting (pleasantness positive and eventfulness positive), the second quadrant corresponds to chaotic (pleasantness negative and eventfulness positive), the third quadrant corresponds to monotonous (pleasantness negative and eventfulness negative), and the fourth quadrant corresponds to calm (pleasantness positive and eventfulness negative).

The SSQP was applied in a total of 509 cases, the median age of the individuals was 23 years old. For the selection of the environments and times for sampling, a preliminary exploration was conducted, which comprised the evaluation of the daily, weekly and seasonal dynamics, as well

as identifying the soundmarks of each environment [25]. Subsequently, the sampling moments for each environment were chosen according with this preliminary exploration, as well as with complementary criteria and pragmatic aspects. As a result, the SSQP was applied between the months of June and December (2013-2015) in different days of the week within the period from 11:00 hrs to 20:00 hrs.

Table 1: Evaluated environments, application cases and sampling strategy considered.

Type of Environment	Name of Environment	Code	City	Application cases	Sampling strategy
Cultural space	Paseo del Buen Pastor	BP	Córdoba	20	F-L
	Fontanarosa Cultural Centre	RC	Rosario	10	W
Park	Bosquecillo of Psychology	BO	Córdoba	74	F-L
	Pabellón Brujas	BR	Córdoba	12	F-L
	City park fountain 1	FP	Lund	20	F-L
	City park fountain 2	FL	Lund	4	F-L
	Jardin Botánico	JB	Valdivia	17	F-L
	Laguna de los Patos	PT	Córdoba	4	W
	Parque Las Tejas Este	TE	Córdoba	11	F-L
	Parque Las Tejas Oeste	TO	Córdoba	3	W
	Parque Nacional a la Bandera	RR	Rosario	10	W
Pedestrian street	Lilla Fiskaregatan 8A	Li	Lund	7	F-L
	Lund Central Station	ST	Lund	10	F-L
	Caseros 50	CS	Córdoba	6	F-L
	San Martin and Córdoba	RP	Rosario	11	W
Square	Bar of Economics	BE	Córdoba	4	W
	Cathedral Square	CA	Lund	9	F-L
	Grand Hotel Square	FT	Lund	4	F-L
	Lund Station Square	FE	Lund	20	F-L
	Lundagard Square	FU	Lund	28	F-L
	Plazoleta Pabellón Argentina	PA	Córdoba	5	W
	Paseo de Sobremonte	SO	Córdoba	26	F-L
	Patio UTN	PU	Córdoba	42	W
	Plaza Barranca de las Ceibas	RF	Rosario	10	W
	Plaza Italia	PI	Córdoba	44	F-L
	Plaza Seca	PS	Córdoba	18	F-L
Street	Ituzaingo 1060	IT	Córdoba	2	W
	Portal of Economics	EC	Córdoba	4	W
Traffic circle	Patio Olmos	PO	Córdoba	9	F-L

Twenty-nine environments were evaluated: eleven squares, nine parks, four pedestrian streets, three streets/avenues and two cultural spaces. These environments are located in four cities: Córdoba and Rosario (Argentina), Valdivia (Chile) and Lund (Sweden). Every environment was evaluated at several locations. The total number of sampled locations was 122. The number of locations and application cases taken have varied among environments according with the interest of studying certain places (in function of the goals of the project, which go beyond the

application of the SSQP) and, in some environments, these numbers were limited due to practical factors (e.g., availability of individuals willing to answer the survey). Table 1 presents the environments evaluated, indicating their type, name, code used for presenting results, city where they belong, numbers of application cases and sampling strategy.

3 Results

Figure 1 shows the mean results of the application of the SSQP in every evaluated environment. Each point in the graphic represents the average of all application cases in the totality of evaluated locations for every environment. These environments were classified according with the type, i.e. parks, squares, streets, pedestrian streets, cultural spaces and traffic circle (see Table 1).

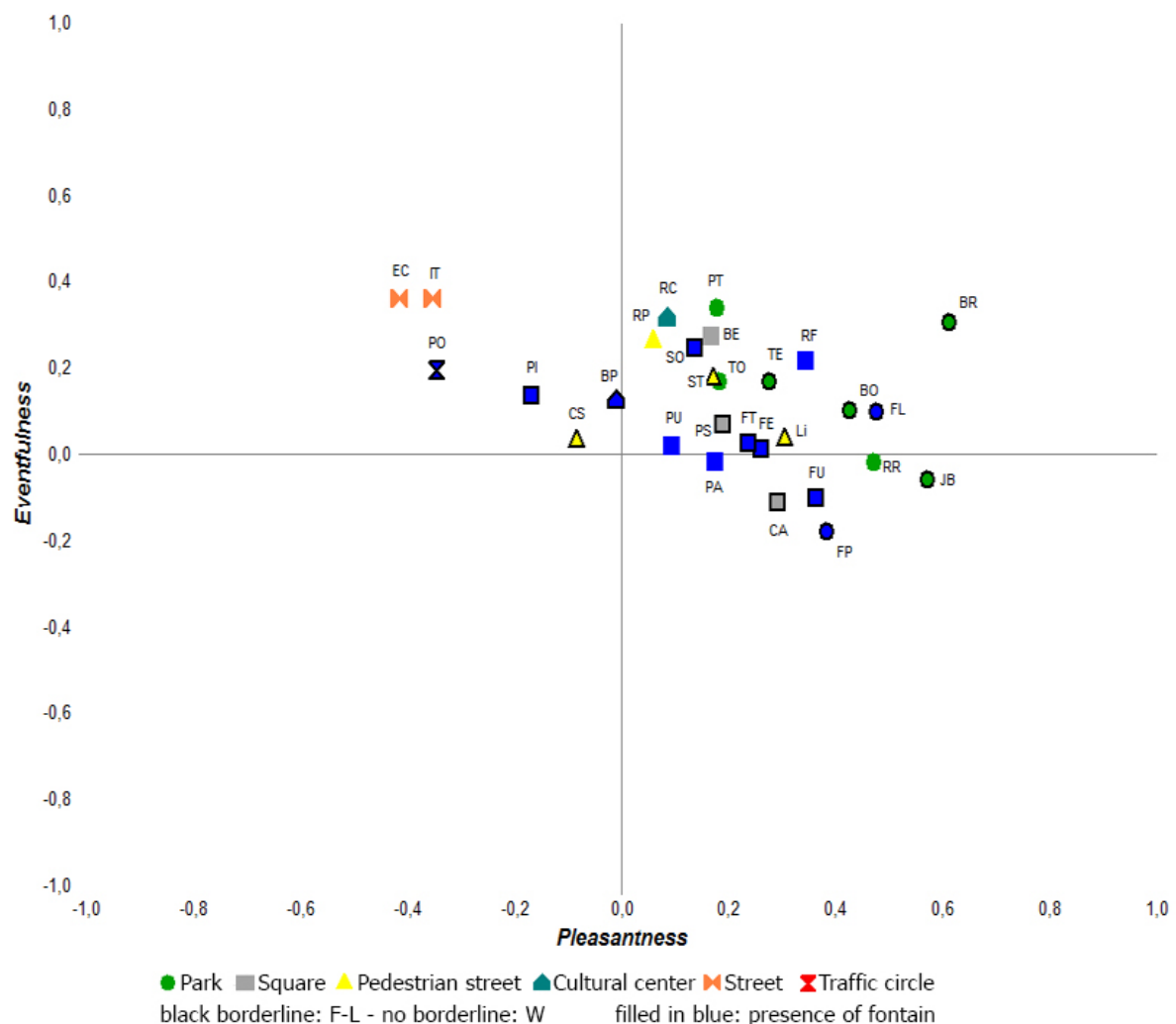


Figure 1: Mean results of the application of the SSQP corresponding to 29 environments of 4 cities (Table 1 shows the reference for each environment).

Each symbol in Figure 1 corresponds to an environment type, as described in the legend. Symbols filled in blue represent those environments containing water fountains. Symbols with black borderline correspond to environments that were sampled using the F-L strategy, while those without borderline correspond to environments sampled using the W strategy.

It can be noted from Figure 1 that most of the urban environments (17) were classified as exciting (first quadrant), while six of them were evaluated as chaotic and another six were categorized as calm (parks and squares). Not a single environment was assessed as monotonous in average. Most locations in urban parks and squares were classified as exciting, while a minority of them was classified as calm. Most locations on streets and avenues were evaluated as chaotic, whereas most pedestrian streets were categorized as exciting. The most pleasant environment corresponded to parks (with dominance of natural sound sources), while the most annoying corresponded to streets and avenues. Neither street or pedestrian street were in both uneventful quadrants (monotonous and calm). Twelve environments that contained fountains are distributed over the exciting, chaotic and calm quadrants. Environments containing fountains in the chaotic quadrant are next to high-traffic ways. In some cases these environments would be even more annoying without the fountain [26]. In spite of that more than half of the environments correspond to Córdoba, the vast majority of them were assessed as eventful. The less eventful environments (calm quadrant) correspond to Lund. All environments found in the chaotic quadrant correspond to Córdoba.

4 Conclusions

The SSQP application confirmed previous results pointing out that most pleasant urban environments are those with predominance of natural sounds, such as parks [8], [16], [27], [28]. In contrast, environments with a predominant presence of traffic were classified as chaotic and were assessed as annoying.

The SSQP was applied in 509 cases corresponding to 122 locations within 29 environments in four cities, ratifying that this protocol represents a very valuable and practical tool for classifying and comparing urban soundscapes, either within a city or transculturally. The SSQP helps to elucidate the sound perception by population, representing a valuable tool for urban management and for designing acoustic environments.

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